may be employed as a substitute for, or in addition to, the relative encoders for measuring the absolute position of the rotary axes of the device.

[0078] The user connection element or stylus **40** of the haptic interface **10** may include a detector **100** for detecting the presence of a user, according to one embodiment of the invention. **FIG. 6** depicts a cross-sectional view of one embodiment of the stylus **40** which includes the presence detector **100**. The presence detector **100** determines whether a portion of a user's body is physically contacting the stylus **40**. The stylus may also include a mechanical push-button switch **98** actuated by squeezing the stylus **40** proximate thereto for other control purposes.

[0079] The presence detector **100** includes an electrically conductive portion **102**, circuitry **104**, and a connector **106** which electrically couples the conductive portion **102** to the circuitry **104**. The conductive portion **102** shown in **FIG. 6** extends along an axial and circumferential portion of an external surface **108** of the stylus **40** which is typically contacted by a user when grasping the stylus **40**. In other embodiments, the conductive portion **102** may extend along shorter or longer portions of the surface **108** in both axial and circumferential directions. In yet another embodiment, the conductive portion **102** may envelop substantially the entire external surface **108** of the stylus **40**. The conductive portion **102** may be composed of any material which conducts electricity. In one embodiment, the conductive portion **102** is composed of conductive rubber.

[0080] The circuitry **104** is electrically coupled to the conductive portion **102** by the connector **106**. The connector **106** shown in **FIG. 6** is a spring contact which presses against an interior surface of the conductive portion **102**. The circuitry **104** is arranged on a printed circuit card which is in electrical communication with a main circuit board of the haptic interface **10** disposed, for example, in the housing **12**. The circuitry **104** detects the capacitance of the user's body relative to electrical ground.

[0081] Referring to **FIG. 7**, the circuitry **104** includes an oscillator **110**, a signal divider **112**, a variable delay **114**, a phase detector **116**, a connector **118**, the push-button switch **98**, and light emitting diodes **122**. The oscillator **110** generates a signal which is input to the signal divider **112**. A capacitor **124** and a resistor **126** of the signal divider **112** generate two pulses. A first pulse **128** is received by a clock input terminal **120** of a flip-flop **130** of the phase detector **116** and a second pulse **131** is received by the variable delay **114**. The variable delay **114** has an input terminal **132** which is electrically coupled to the conductive portion **108** by the connector **106**. The variable delay **114** delays the second pulse **131** from reaching the phase detector **116**. If the user is contacting the conductive portion **108**, the capacitance of the user changes the capacitance of the variable delay **114** and delays the second pulse **131**. A Schmitt trigger **134** operates to square up the second pulse **131** into a square wave pulse **136** which is received by a D input terminal **135** of the flip-flop **130**. The amount that the pulse **131** is delayed depends on the capacitance of the user.

[0082] In the embodiment shown in **FIG. 7**, the input to the D terminal **135** of the flip-flop **130** will be high or asserted if the user is not contacting the conductive portion **108**. If the user is contacting the conductive portion **108**, the pulse **136** is shifted to the right and the input to the D terminal **135** of the flip-flop **130** will be low or unasserted. The flip-flop **135** outputs a signal at a Q terminal **136** thereof which indicates the presence or absence of a user. This signal is read by the system computer which may enable or disable the haptic interface **10** or take other actions based on this signal. In one embodiment, the haptic interface **10** upon detecting the absence of the user will actively maintain its last orientation so that the user may later conveniently re-grasp the device at the same location.

[0083] In one embodiment, the variable delay **114** includes a surge protector **140**. The surge protector **140** protects the circuitry of the variable delay **114** from surges of electricity, such as sparks of static electricity which may come into contact with the conductive portion **108**.

[0084] Velocity limits may be provided for each of the powered axes to safely limit the speed of axes A-C in the event of a system programming error or system malfunction. In one embodiment, the velocity limits may be implemented using computer hardware, for example, by providing for maximum actuator rotational speed limits for each of the axes in an integrated circuit or otherwise. These maximum actuator speeds are typically different, due to the different geometric and mechanical configuration of each powered axis. In the event the limit is exceeded for one or more axes, the system may dynamically brake the actuators electrically to slow the errant axis or otherwise disable the axis. In the embodiment where the actuators are DC motors, the actuators can be effectively braked by shunting the inputs to the motors. Velocity limits may be implemented in system software, either redundantly in addition to the hardware limits, or alternatively. If used in a redundant system, these software limits may be implemented advantageously at levels slightly below those of the hardware limits so that they are triggered first.

[0085] A wrist rest or other structure may be provided to support a user's wrist and/or arm at a predetermined or adjustable height and orientation to address ergonomic concerns with prolonged or extended use of the haptic interface. As used herein, the term wrist should be considered to refer to any area of a user's arm, from the palm to the elbow, inclusive. **FIG. 8A** is a schematic side view of an ergonomic representation of a user employing the haptic interface **10** in combination with a wrist rest **142** and other system components in a desktop environment. **FIG. 8B** is a schematic top view of the ergonomic representation depicted in **FIG. 8A**. By elevating a user's wrist so as to position the user's hand generally within the center or upper portion of the work volume of the haptic interface **10**, the forearm and wrist may be maintained in a natural, neutral orientation for comfortably grasping and manipulating the stylus **40**. Naturally, if the user connection element were a thimble or other structure designed to be donned or grasped by the user in a different orientation, the height and orientation of the wrist rest **142** could be made adjustable. As depicted herein, the wrist rest **142** is connected to the haptic interface **10**, although a separate stand alone wrist rest with appropriate height and orientation could be used. The haptic interface is disposed advantageously proximate a system keyboard within easy reach of a user, typically inboard of a mouse pad area.

[0086] FIGS. **9A-9D** are schematic top, side, end section, and partial section views of a contact pad **144** for use in the